
Hurricane Protection and Storm Damage Reduction Modeling

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Project Organization

- Developer Group—Lead PDT
- Test Site Group—PDT members
- Technical Oversight Group—Corps and non-Corps Experts
- Peer Review—Non-Corps



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Lead Members PDT

- Dave Moser, CEIWR, Project Manager & Economics
- Mark Gravens, CEERD, Coastal Engineering
- Mike Wutkowski, CESAW, Coastal Engineering
- Dick Males, RMM, System Architecture & Model Development
- Corey Rogers, PMCL, System Integration & User Interface
- Josh Tirey, PMCL, User Interface



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Other Members PDT

- Bob Finch, CESAW, Economics
- Frank Reynolds, CESAW, Economics
- Ken Claseman, CESAM, Test Site
- Bernard Moseby, CESAM, Test Site
- Linda Lillycrop, CESAM, Test Site



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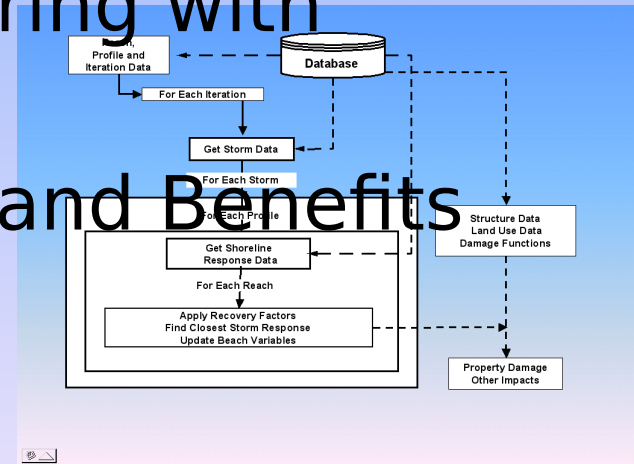
Needs and Problems

- Growing Corps hurricane and coastal storm protection program
- No standardized model to estimate storm damages
- The benefits and costs of protection are highly uncertain



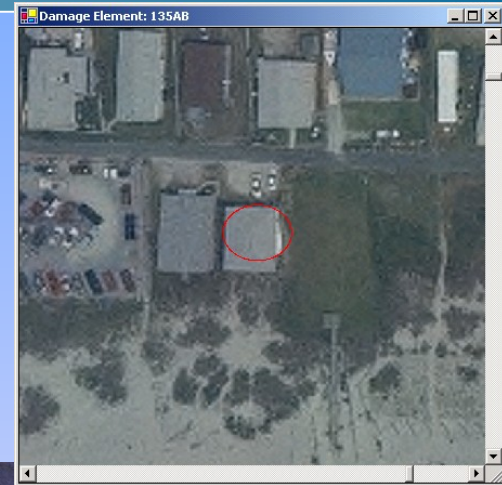
Model Implementation

- Event based Monte Carlo Model
- Life-cycle Approach—50 Year Future
- Uncertainty in Model Variables
- Integrate Coastal Engineering with Economics
- Compute Life-cycle Costs and Benefits



Model Components

- Storm Generator using Plausible Storm Population
- Shoreline Storm Response Profiles
- Planform Evolution
- Damage Elements
- Damage Functions
- Policy Options
- Text and Graphic Report Generator

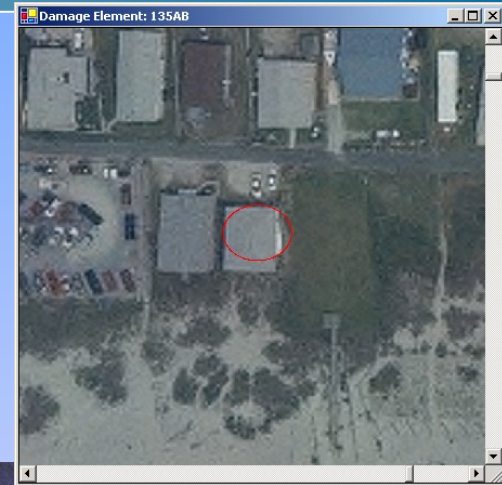


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Plausible Storm Population

Historical and Plausible Storm Events

- Identify Historical Storm Events
- Extract historical storm surge hydrographs
- Generate equilibrium tidal information
- Obtain storm wave information



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Plausible Storms

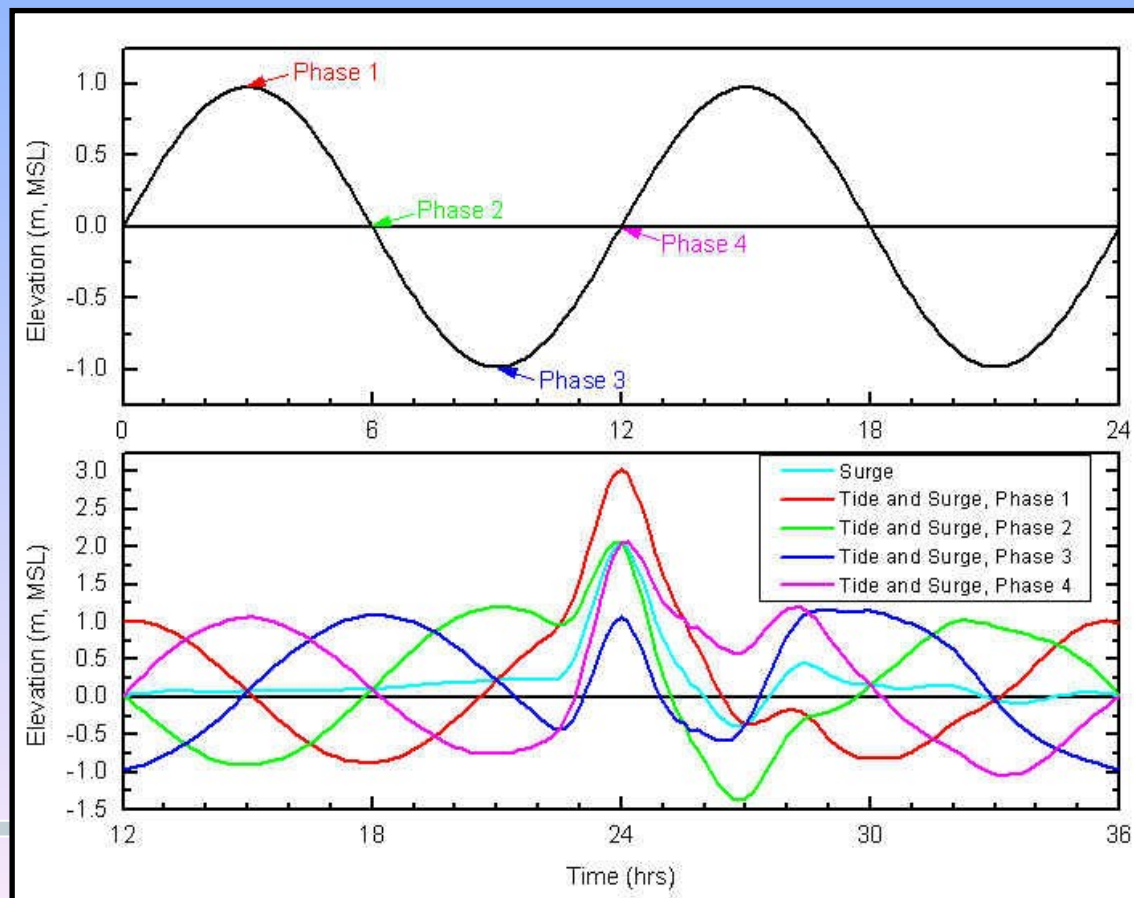
Development Example Site

- 23 extratropical storms
- 37 historical tropical storms
- Historical predicted tide
- 3 tidal ranges
- 4 hydrograph – tide phase combinations
- 299 extratropical storms
- 481 tropical storms



Characterization of the Storm Climatology

Phasing of Tide and Surge Hydrographs



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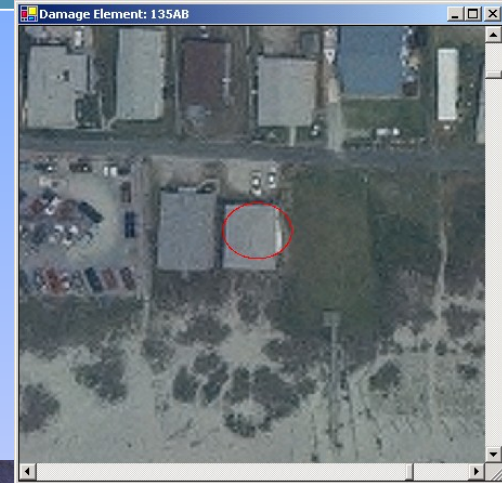


Model Components

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Shoreline Storm Response Profiles

- Life-cycle requires prediction of future profile
- Post-storm profile based on pre-storm profile and cross-shore storm effects
- Account for natural storm recovery
- Process over life-cycle is Profile Evolution



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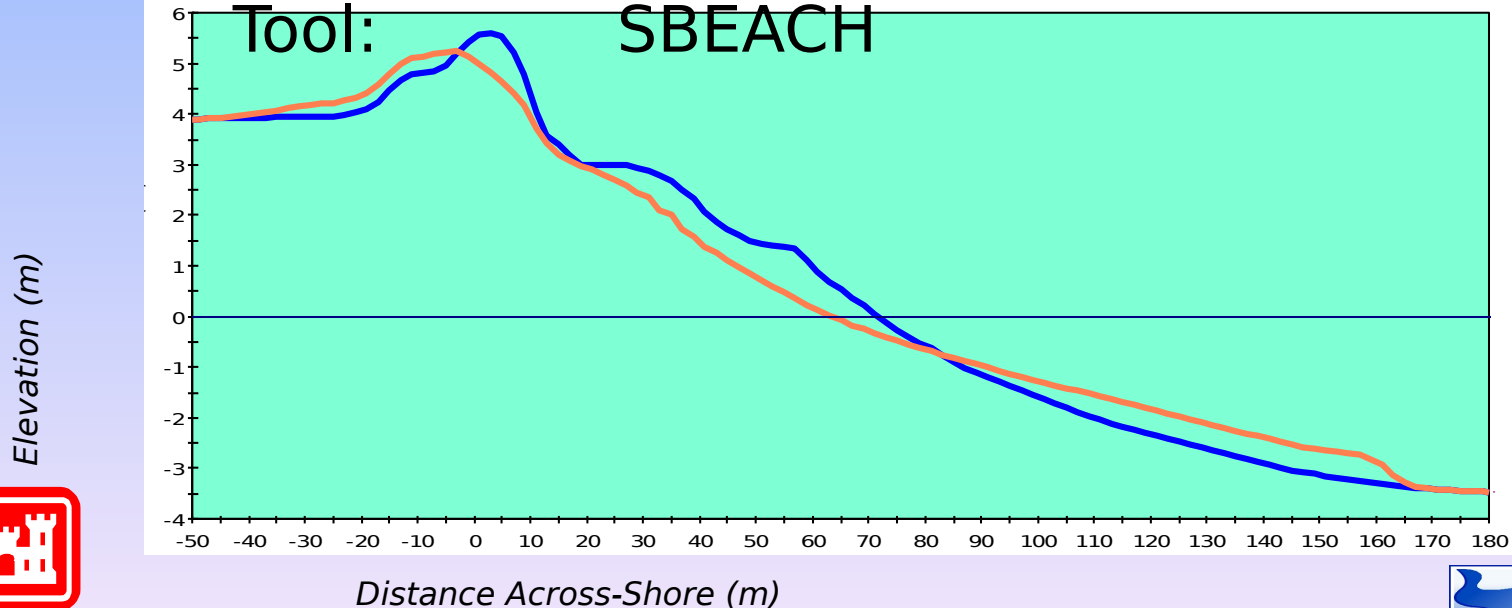
Profile Evolution

Beach Profile Change

Time scale: Short-term

Process: Cross-shore
transport

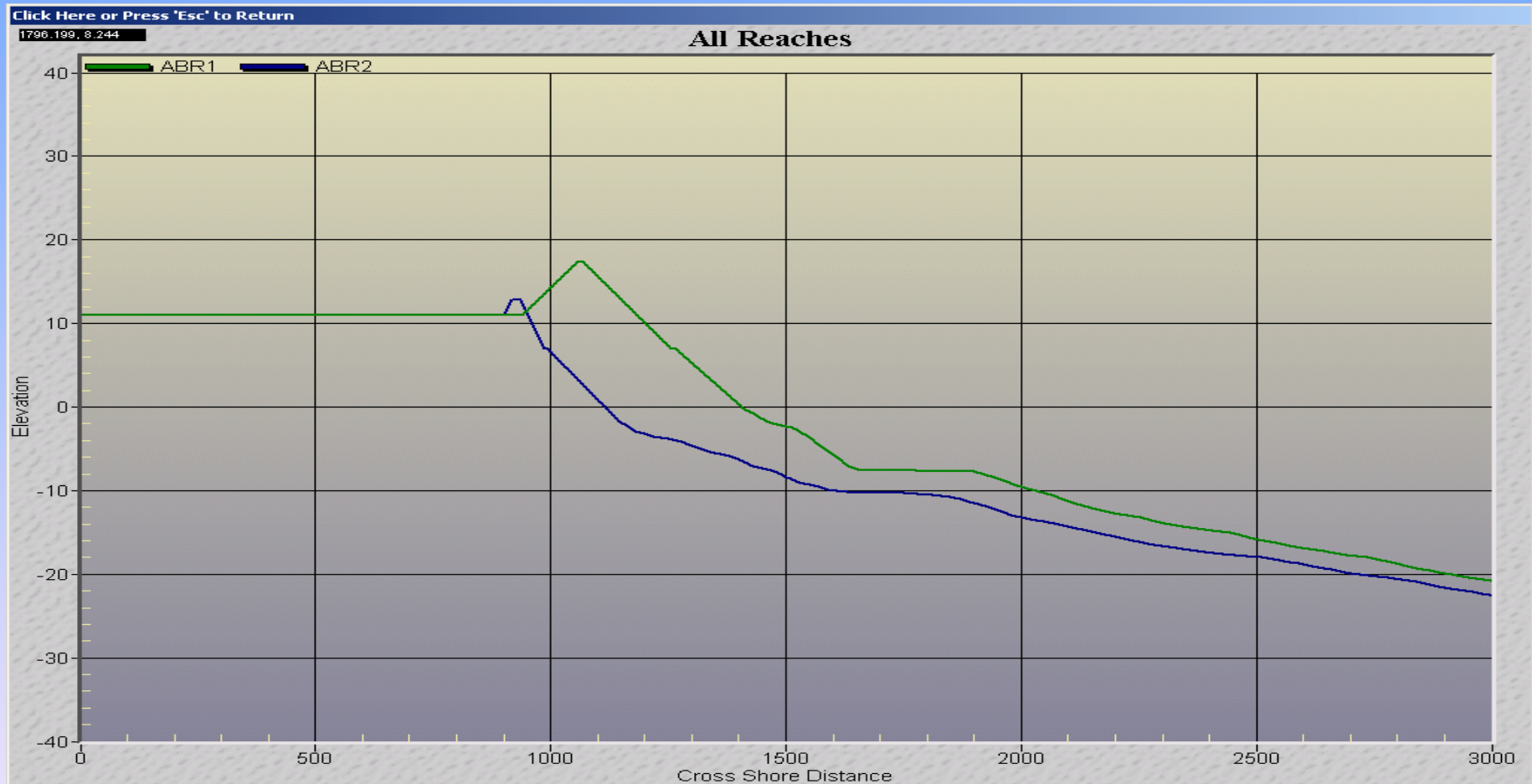
Tool: SBEACH



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Simplified Shoreline Profile



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Future Pre-storm Profiles

- The model needs to have estimates of profile response to storms for all potential future profile conditions.
- The largest design cross-section, with advance nourishment in place, defines the maximum profile condition



Implementation of Profile Evolution

- Pre-computed post-storm profiles for all combinations of user specified pre-storm profiles and plausible storms
- Lookup Shoreline Response Database (SRD)



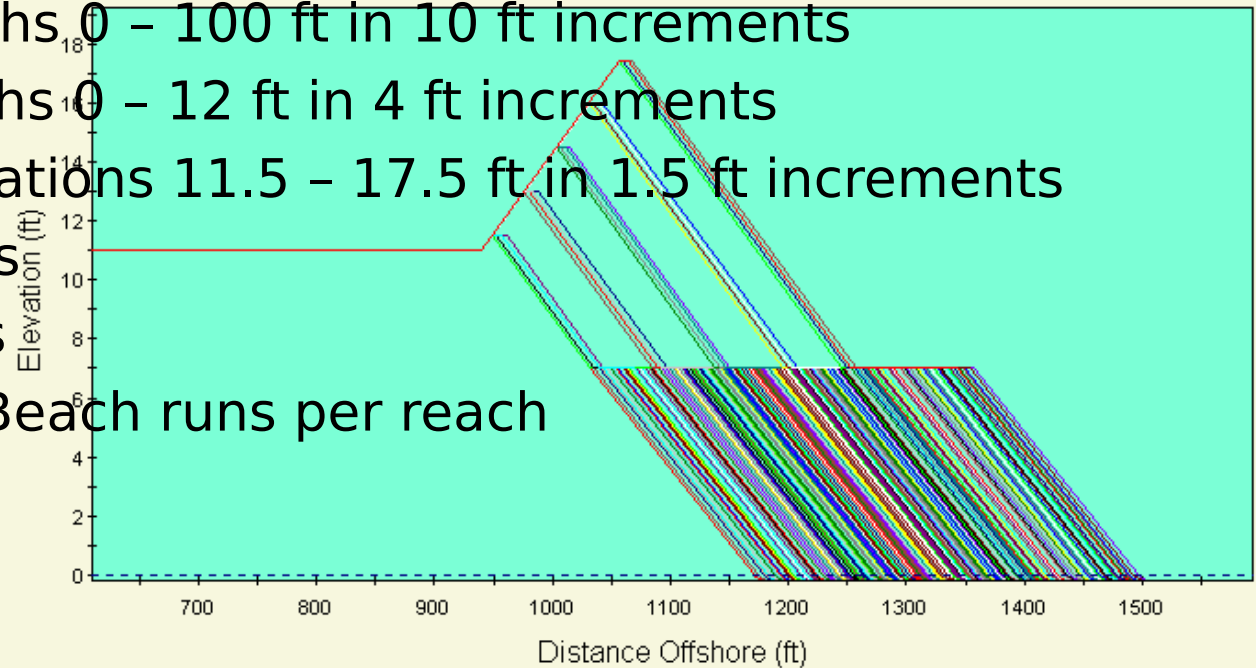
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Pre-computed SRD

Example –

- 2 Reaches
- 11 berm widths 0 – 100 ft in 10 ft increments
- 4 dune widths 0 – 12 ft in 4 ft increments
- 5 dune elevations 11.5 – 17.5 ft in 1.5 ft increments
- ~ 220 profiles
- ~ 780 storms
- ~ 170,000 SBeach runs per reach

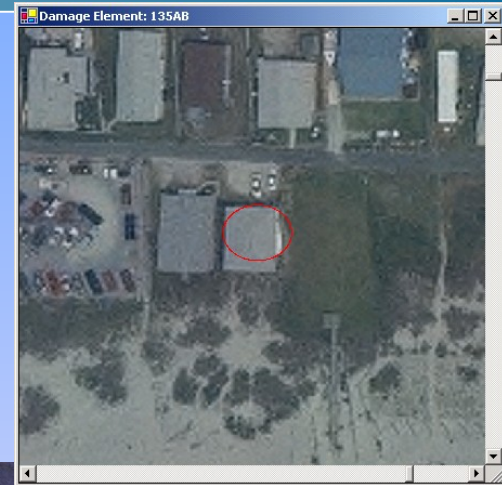


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Planform Evolution

- Accounts for long-term trends
- Shoreline changes observed as historical shoreline change (non-recoverable) and beach planform changes



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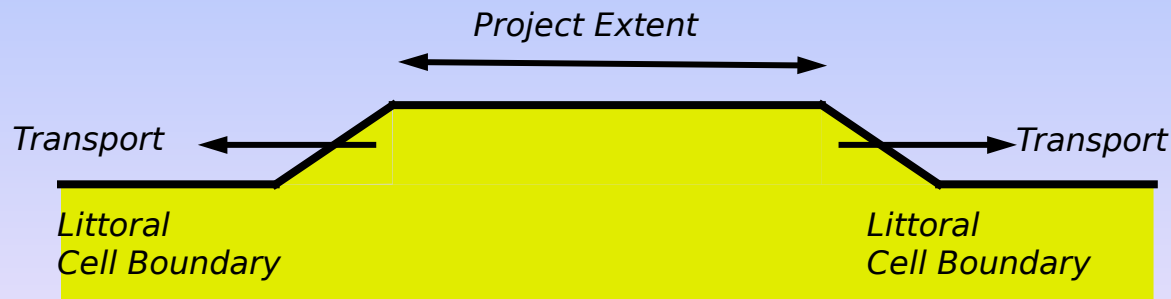
Planform Evolution

Planform (Shoreline) Beach Change

Time scale: Long-term

Process: Longshore transport

Tool: GENESIS



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Including Planform Evolution in Monte Carlo Model

Without explicit treatment of longshore transport processes (planform evolution) dispersion of nourishment material from the placement area will not be simulated in the Monte Carlo model.



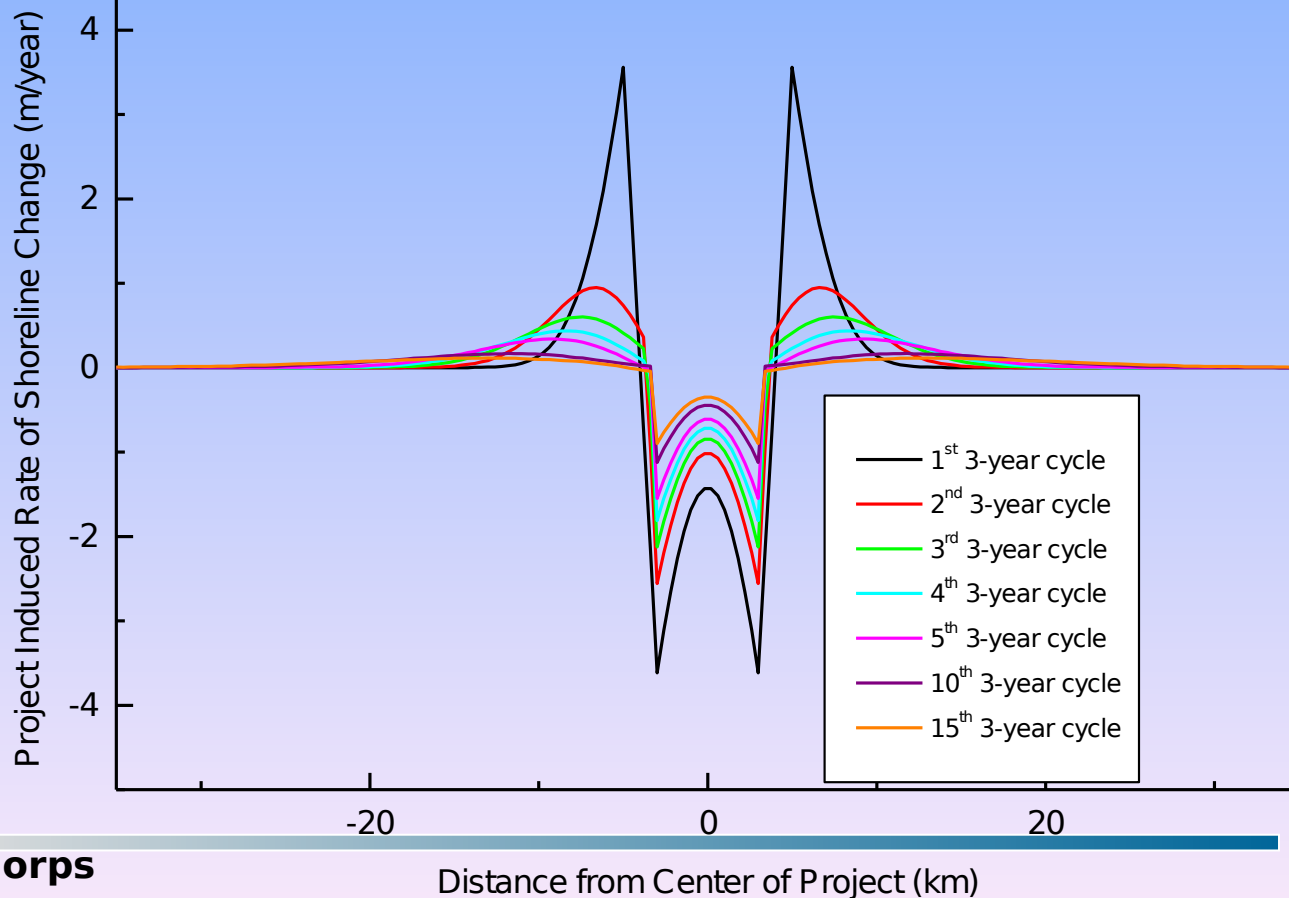
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Planform Evolution

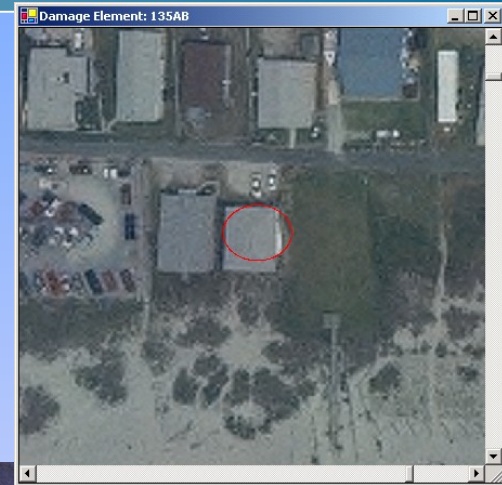
Simplified Example (stable shoreline)

Project induced shoreline change rates



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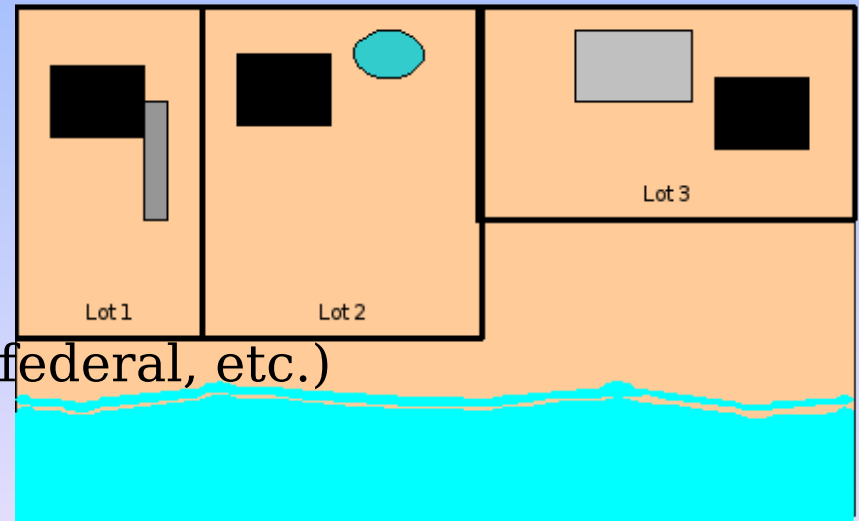
Damage Elements

- Inventory of damageable items
- Location / Hierarchy
 - Reach
 - Lot
 - Damage Elements
- Attributes
 - Construction / Foundation / Land Use Type
- Values
 - Structure / Contents / Land



Lot Information

- Location as Bounding Rectangle (SPC)
 - Max/Min Easting
 - Max/Min Northing
- Additional Info / Attributes [Not currently used by model]
 - Lot Type
 - External Identifier
 - Description
 - GIS reference
 - Ownership (private, state, federal, etc.)
 - Area
 - Land Value (Distribution)
 - Max / Min elevation

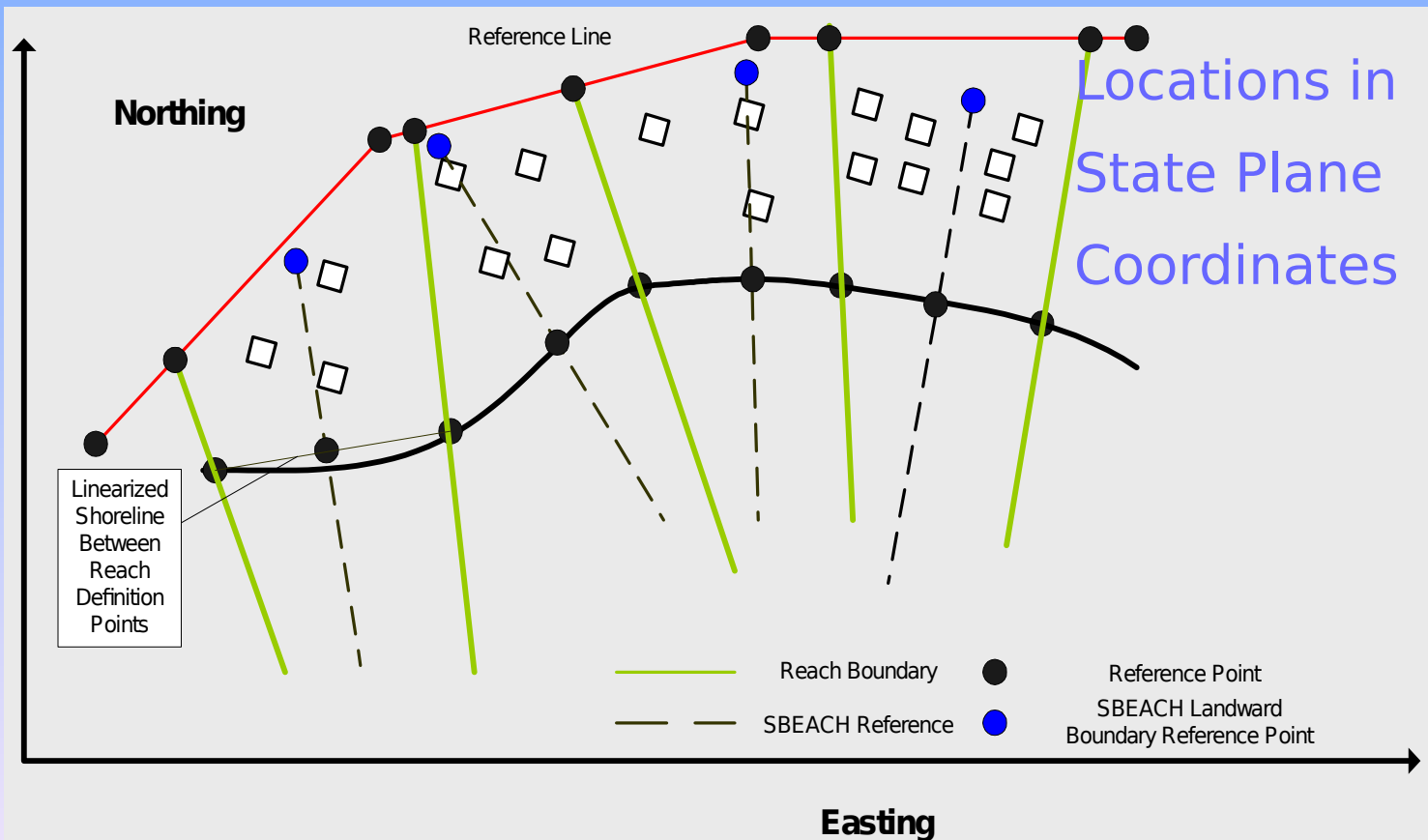


Damage Element Information

- Lot
- Bounding Rectangle
- Width / Length
- First Floor Elevation (distribution)
- Ground Elevation / Location of Ground Elevation
- Structure / Contents Value (distribution)
- Description
- Foundation / Construction / Usage / Armor Type
- Other miscellaneous information (not currently used)
 - Time to rebuild distribution
 - Condition Indicator
 - Number of floors



Coordinate System

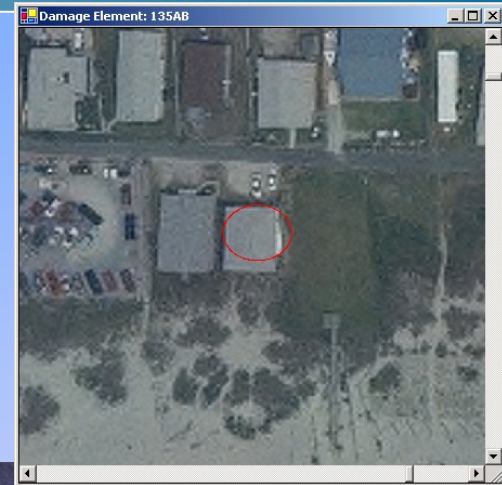


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Damage Functions

- Relationships predicting damage to damage elements as function of driving parameter
- User defined curves with uncertainty
 - % Value Damaged = $f(\text{Driving Parameter})$
- Driving Parameter is damage type-specific:
 - **Flooding**: Depth of water over lowest walking floor
 - **Waves**: (Wave crest elevation) - (lowest horizontal member elevation)
 - **Erosion**: % of footprint compromised



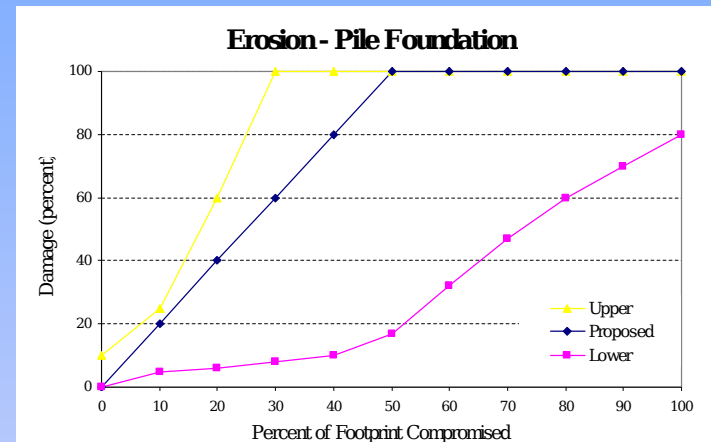
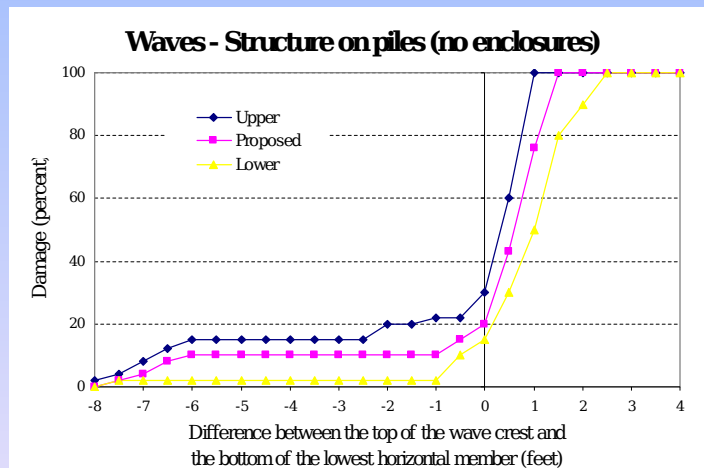
Damage Functions

- Each damage function incorporates uncertainty
 - Lower, Most Likely, Upper
- Separate damage functions based on
 - Damage Element Type (house, walkway, etc.)
 - Damage Type (wave, flooding, etc.)
 - Foundation Type
 - Construction Type

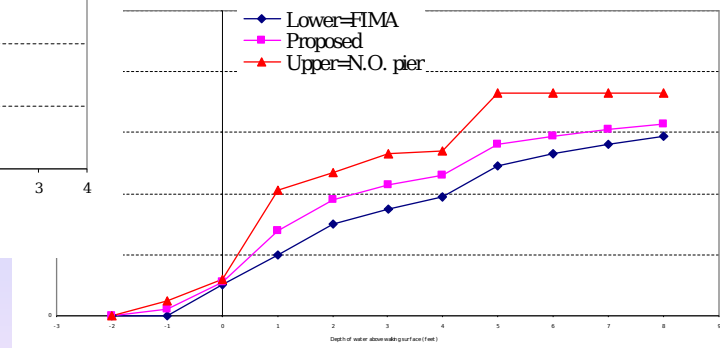


Example Damage Functions

- Erosion
- Wave
- Flooding

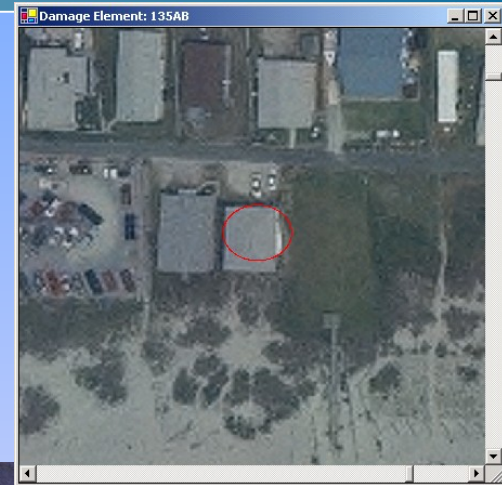


Wood frame with piles (no enclosures)



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Planning & Evaluation Features

- Nourishment strategies
 - Planned
 - Emergency
 - Environmental windows
- Armoring Policies
- Rebuilding Policies
- Non-structural Policies

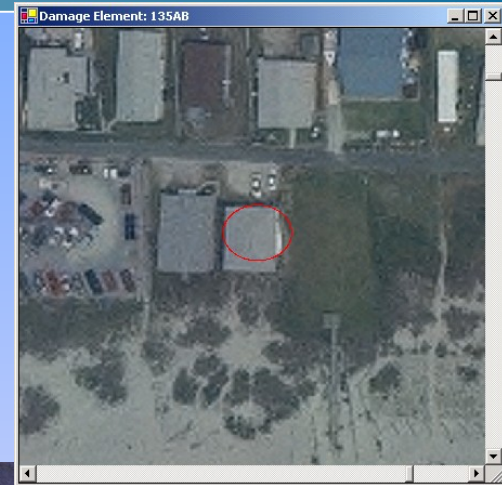


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Model User Interface

Shoreline Protection - [Explorer]

File Launch Results Window Help

Navigation Pane

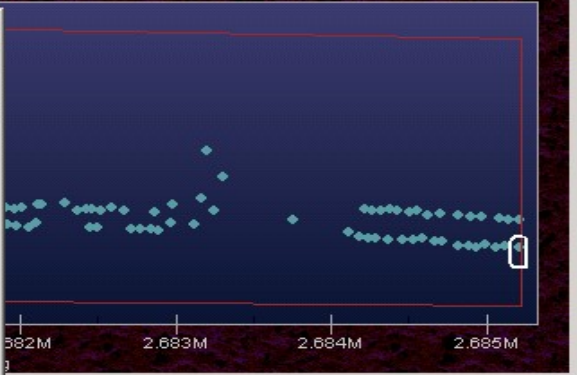
- Atlantic Beach
 - Profiles
 - ABR1
 - ABR2
 - Detail Submerged Profile
 - Reaches
 - ABR2
 - Emergency Nourishment
 - Planned Nourishment
 - Lots
 - 10649
 - 10657
 - 10673
 - 10682
 - 10695
 - 10710
 - 10735
 - 10757
 - 10774
 - 10781
 - 10801
 - 10825
 - 10836
 - 10850
 - 10864
 - 10881
 - 10893
 - 10927
 - 10935
 - 10944
 - 10945
 - 10952
 - 10958
 - 10967
 - 10993
 - 11008
 - 11013
 - 11018
 - 11021
 - 11022
 - 11023

Graphics Pane

Profile View Plan View

Reach: ABR2

Damage Element: 71AB



Land Use Type	Bounding Rectangle Max Northing	Bounding Rectangle Max Easting
0	352623.343	26852
0	352627.717	26851
0	352632.684	26850
0	352636.466	26850
0	352641.34	26849
0	352647.026	26849
0	352651.464	26848
0	352658.838	26847
0	352662.899	26846
0	352666.867	26846
0	352670.617	26845
0	352676.302	26845

Land Use Type	Lot ID	Bounding Rectangle Max Northing	Bounding Rectangle Max Easting
Residential	10774	0	0
Residential	10781	0	0
Residential	10801	0	0
Residential	10825	0	0

Project: Atlantic Beach

Connected

Up To Date

Version: 0.0.1.200

3:30 PM

11/10/2003

Start

Inbox...

Mose...

Males...

Grav...

Shore...

C:\Pr...

Gove...

tblSto...

Dam...

3:30 PM

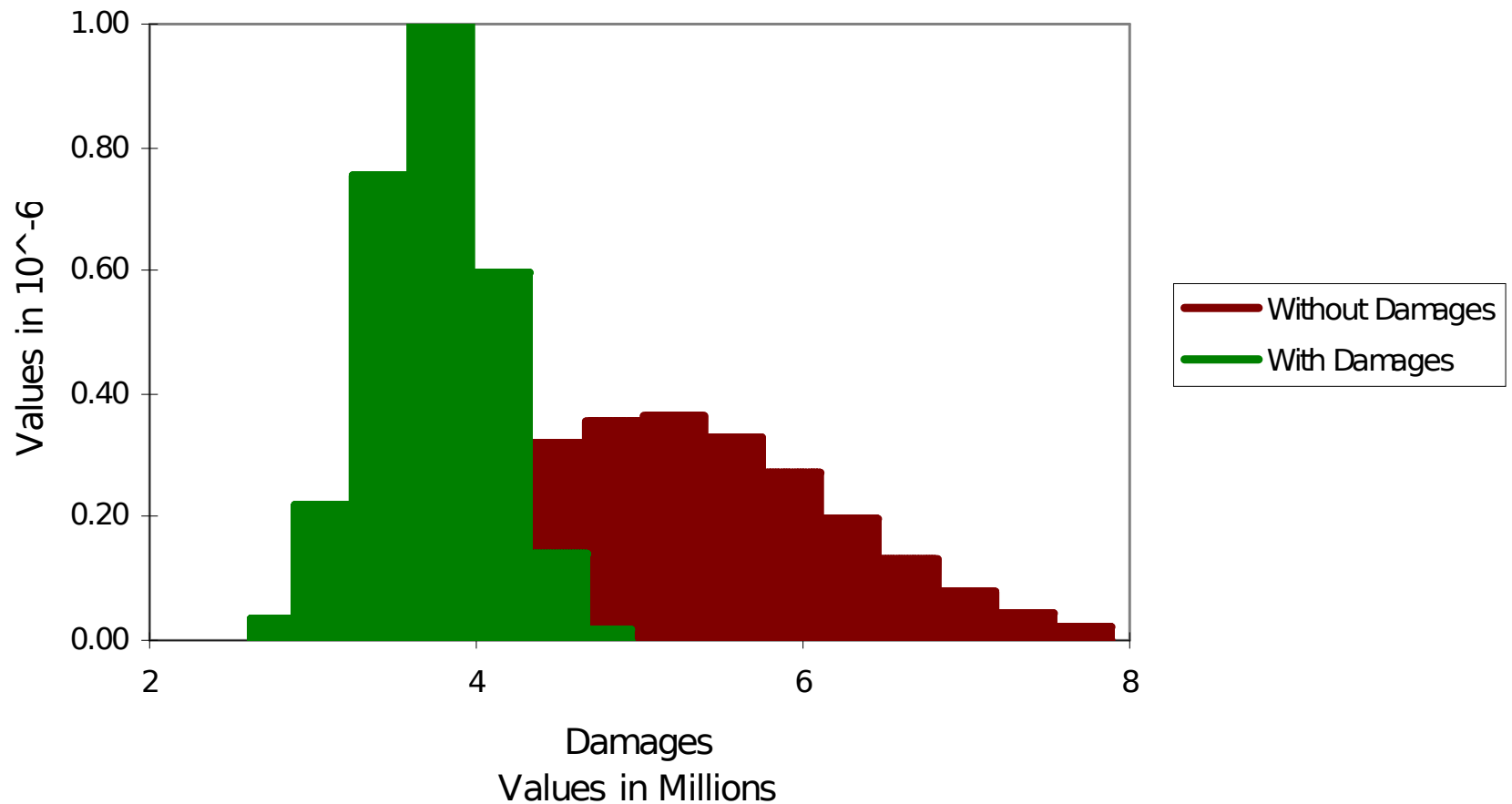
Prototype Text Report

Shore Protection Model Run on 10/27/03 09:44:47						
Database: C:\Program Files\Shoreline Protection\Data\Governor.mdb						
Start Year: 2001 Month: 1 Base Year: 2007						
Iterations: 2 Years: 50						
Interest Rate: 0.085						
Scarping Enabled						
Kernel Version: 0.2610						
Simulation Output						
=====						
Land Loss Cost						
R:	ABR1 S:	2	1,141,218.7	72,074.9	1,192,183.4	1,090,254.1
R:	ABR2 S:	2	3,522,497.3	2,506,947.3	5,295,176.8	1,749,817.9
Damages						
Total Structure:		2	12,832,664.5	5,977,545.8	17,059,427.7	8,605,901.4
R:	ABR1 S:	2	3,735,875.1	1,763,478.5	4,982,842.7	2,488,907.5
R:	ABR2 S:	2	9,096,789.4	4,214,067.3	12,076,585.0	6,116,993.9
Nourishment						
Mobilization		2	16,913,973.7	0.0	16,913,973.7	16,913,973.7
Placement		2	72,236,436.7	21,044,639.9	87,117,244.3	57,355,629.1
Storm Generation						
NE Season: 1		100	1.210	1.028	4.000	0.000
NE Season: 2		100	0.000	0.000	0.000	0.000
NE Season: 3		100	0.000	0.000	0.000	0.000
NE Season: 4		100	0.370	0.614	3.000	0.000
H Season: 1		100	0.000	0.000	0.000	0.000
H Season: 2		100	0.000	0.000	0.000	0.000



Example Output

With vs Without Distribution



Model Status

- Model under development
- Test bed started Mar., 2004
 - Walton County, FL
- GIS visualization to be expanded
- Armoring algorithms to be refined
- Version 1.0--2004

